mdot **mx**
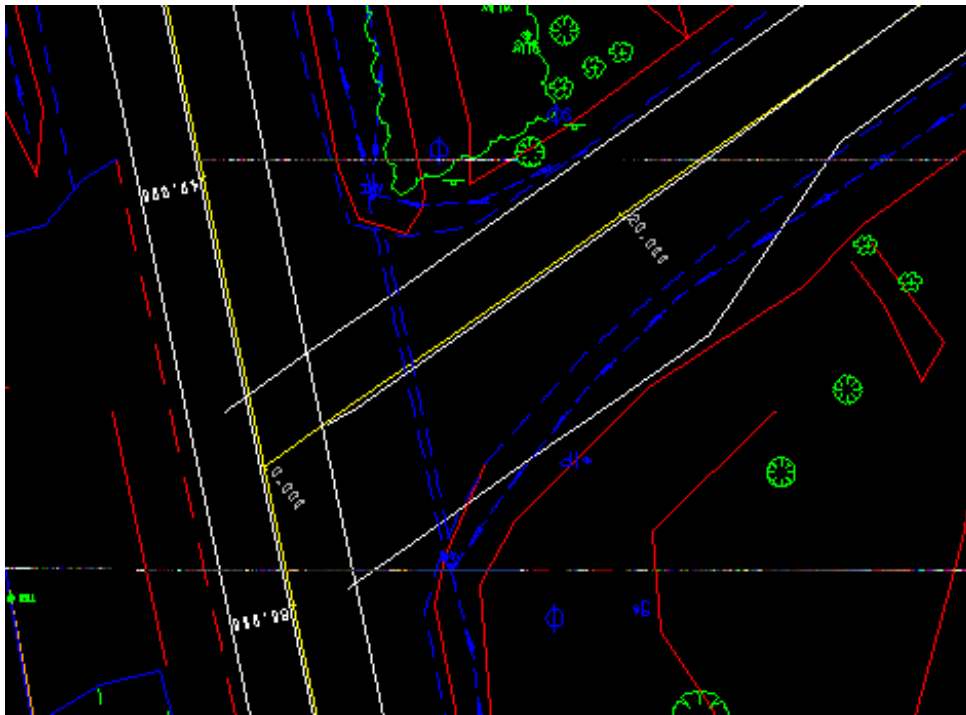
Chapter 10 <u>Intersection Design</u>

MXRoad provides some really handy automated procedures for intersection design.   The model used for the training class has 3 intersections on it. For this example, we'll use the northernmost one.

<u>Before continuing with this step, you must first create a horizontal and vertical alignment for the side road, then apply a template and widening to it as well.</u>

When you have done this, your intersection should look something like this:

The widening shown in the illustration above will be used to create a right turn lane at the intersection, and a triangular-shaped traffic island.

Create Curb Returns

We start our intersection design by creating curb returns between the edges of traveled way of the mainline and side road.

<u>Step 1</u>: Create Intersection Curb Returns. Select ***Design, Intersection Design***, then ***Create Curb Return*** from the menu bar or MXRoad toolbar.

You'll see the following panel:

The through road string is the edge of traveled way for the mainline roadway and the intersection road string is the edge of traveled way for the side roadway. The radius is self-explanatory. You can choose to create a 3-centered curve by checking the box on the panel, otherwise a simple circular curve will be used.

Clicking **Next** after the data is entered will create the curb return, draw it in the display, and a panel will pop up providing you some options as to whether or not to accept the curve:

If you want to change the radius, click on the **Back** button. If you want to totally quit the wizard, click the **Cancel** Button. If you want to accept the curb return and do another, click the **Next** button. And finally, if you'd like to accept the curb return and exit, click the **Finish** button.
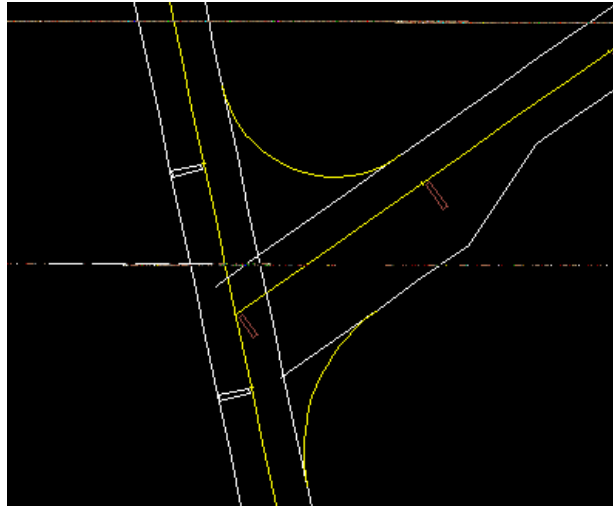
Step 2: Repeat Step 1 for the remaining Curb return. The intersection with curb returns should appear like this:


Regrade Intersection

Step 3: Now that our curb returns are in place, we need to make sure there are no flat spots on them, and set the low point for drainage. From Menu Bar, select *Design, Intersection Design, then Regrade Intersection.* The following panel will appear:

Select the **Curb Return** string, and specify a **lead in distance** and **lead out distance** on this panel. _Lead In and Lead Out Distances_ are lengths along the edges of traveled way (tangents) to our curb return which will be displayed/altered during the regrading operations.

On the **Ground Profile** tab, specify the TRIANGLES (TRIA) model and triangulation String TRIA, and then click **Next.**

Step 4: The Regrade Intersection Quick Profile will appear in the display area, displaying your curb return profile along with lead in and lead out distances. The actual curb return is located between the two vertical white lines. You can construct a gutter line profile using the same tools described under Chapter 5 – Vertical Alignment. The only difference is that "next and back" buttons have replaced the "OK" button since we are in a wizard. These buttons are the left and right blue arrows on the right side of the toolbar.
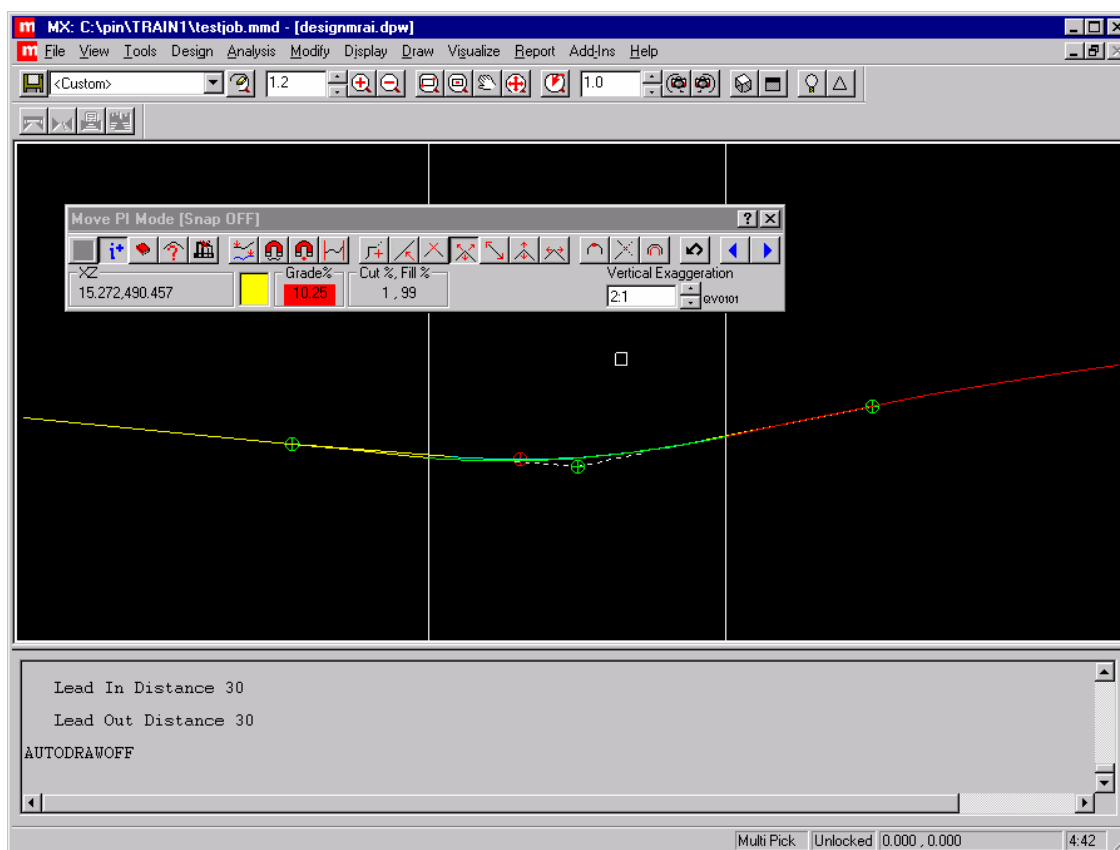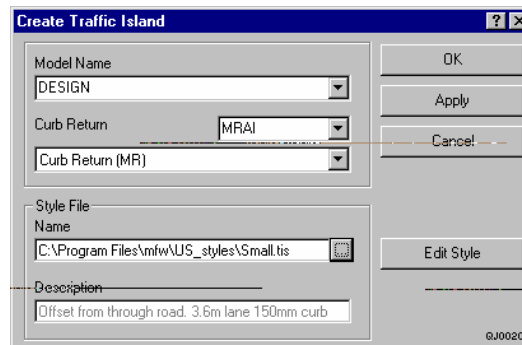

This is pretty much the same vertical grade control that you used for roadway alignments. The low point on the grade is indicated by a red dot. When you're satisfied with the proposed grade for your curb return, click on **OK** to continue.

Create Traffic Island

MXRoad has a wizard which helps you to create triangular traffic islands such as you might find used to delineate a right turn lane. It's important that you perform roadway widening where these islands are to be placed to provide enough room for both a through lane and a turn lane. Here's how you create one of these triangular islands with the wizard:

Step 1: Select **Design**, **Intersection Design**, then **Create Traffic Island** from the Menu Bar.
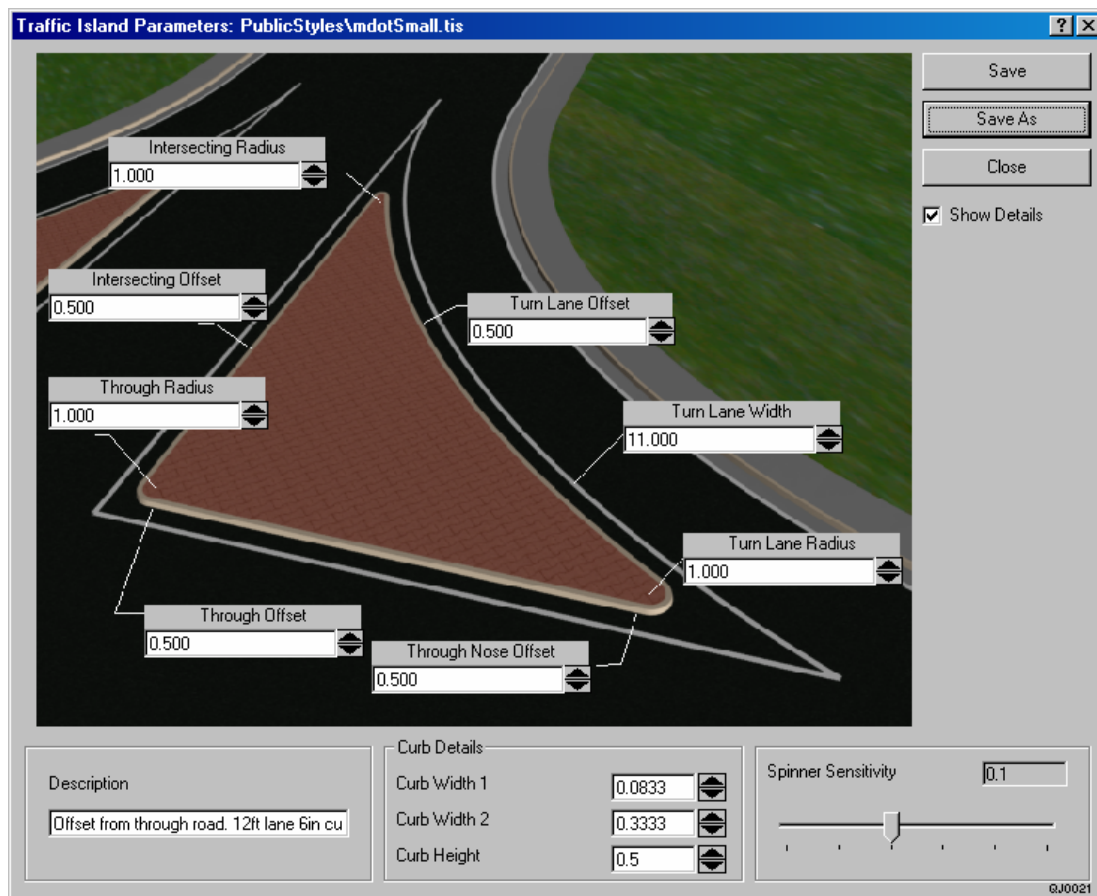
Step 2: A panel will appear, prompting your for the design model and curb return string which will be used to create the island. You'll also be asked to choose a Traffic Island Style File.
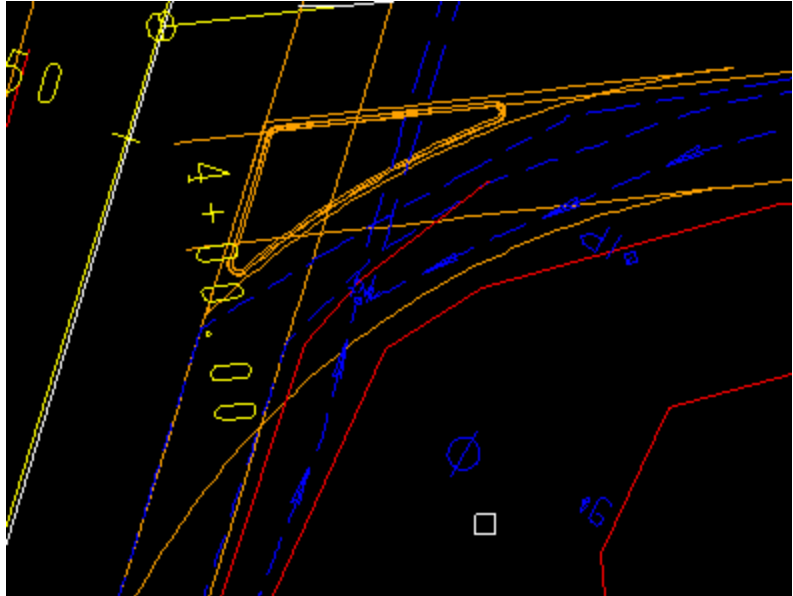

By clicking on **Edit Style**, you can modify the traffic island style file, and save it as a new island style.

Step 3: Click *Apply* to create the traffic island. It should look something like this:

Tidy Intersection

At this point, MXRoad provides a new function, which automates some of the string editing which needed to be done in the past manually. It's called Tidy Intersection. In order to use this functionality, you must have created your curb returns with the wizard.

Step 1: Choose *Design, Intersection Design, Tidy Intersection* from the Menu Bar.

Step 2: A panel will appear asking you to specify the name of the curb return. Select a string from the display, or label from the drop-down box. Click *Next* to perform the actions, and the panel will remain, allowing you to specify the other curb return. The results are as follows:
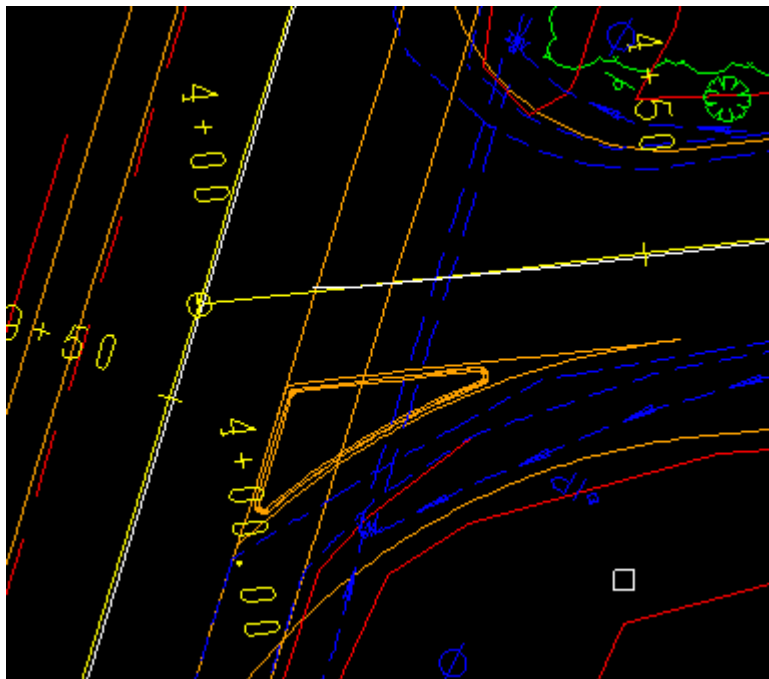
Manual Method Of Creating Intersections

In addition to the MX Road Intersection design wizard, you may also choose to design an intersection manually. If you use this method, go ahead and create edge of shoulder strings for your mainline and side road before continuing.

Create Circular M-Strings

To create the radii that connect our edges of travel way, we'll use ***Major Option DESIGN, Minor Option 145 Create Circular***. The string created by this option is a Master string, so it will begin with the letters "MR". The third character will the the third letter of our side road Master Alignment name. (i.e. "A" for MCA1, "B" for MCB1, etc.)   For sideroad MCA1's intersection, this will give us "MRA" for the first 3 letters. The fourth and final character will be named in accordance with the normal naming convention for left and right sides. (i.e. "I" and "0").
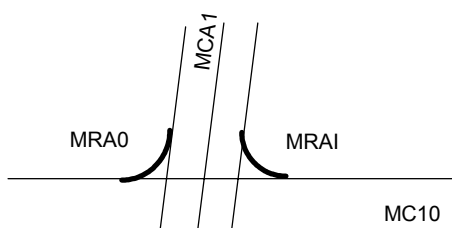

Side Road	Left Side	Right Side
MCA1	MRA0	MRAI
MCB1	MRB0	MRBI
MCC1	MRC0	MRCI

The field definitions for Minor Option 145 are:

Minor Option 145 - Create Circular

```
        * Field 1            First String Label

        * Field 2            Second String Label

        * Field 3            String To Be Created (Must start with M)

        * Field 4            Radius for string to be created

        * Field 5            Chainage Interval

        * Field 6            Chainage of Initial Point.  This is the point at which the string
is                                tangential to the string in field 1

        * Field 7            Offset of element center from first string

        * Field 8 & 9        Approximate coordinates of element center (optional)

        * Field 10           Offset of element center from second string.
```

Remember to use the correct sign for the offsets from the edge of traveled way strings. The radius will also be positive or negative, depending upon the relationships between the directions of the two edges of traveled way. If the radius is entered with the incorrect sign, it will draw a big circle in the opposite direction that you had intended to create your curb return. If this happens, simply change the sign of the radius to correct the problem.

Circular M-Strings for the Intersection of Side Road "A" (MCA1), and Mainline (MC10) are created in MX as follows:

Create Circular M-String For Left Side (MRA0)

1. Open a JOURNAL file. Use a descriptive name such as "C-INTERSECTION-MC20.INP".

2. Select **Design => Design A String => Single Arc Between 2 Strings** from the menu bar. The following panel will appear:

You must now fill out the information on all 3 tabs of this panel.

3. *On the Details Panel*: type the new string label (MR20), and click the edge of traveled way first for the mainline roadway, then the side road.

4. *On the Arc Panel:* Type the Arc radius, specify whether it's a left-hand or right-hand arc, then specify the offsets of the center of this arc from string 1 and string 2 defined on the Details Panel. You also need to specify a left/right offset of the center point from these strings by clicking the appropriate arrow button.

5. **On the Options Tab:** Since we're creating a master string, it needs a station interval. Specify the station interval, and if more than one intersection of string 1 and string 2 exists, specify the approximate location of the Arc Center. Then click Apply.

At this point the circular M-String will appear in the Display Area. If you need to change any values to define this string, do so in the appropriate panel, and click **Apply** again.

Create Circular M-String for Right Side (MR2I)

Repeat the previous steps for the radius on the right side of the intersection. You should still have the same JOURNAL file open recording your INPUT.

Create Edge of Shoulder String - Left Side (ES20)

After the M-Strings have been created, add an edge of shoulder string (ES20) based on the new M-String (MR20). This string will be created using the "Add/Amend String" Minor Options in Major Option DESIGN.   More often than not, you'll want to use **Minor Option 101, Add String: Linear H / Constant C** since your shoulder widths will likely be different on your mainline and side roads. Here is the step by step procedure to create ES20:

1. Select **Design => Design A String => Horizontal Offset** from the menu bar. A panel will appear with 4 tabs on it.

2. **On the Details Tab**, specify the Curb Return M-String (MR20) as the Reference String, and select Shoulders (Edge)(ES) in the New String Name box. Be sure that the box is checked to create a new string.

3. **On the Horizontal Offset Tab**, select "Linear", then enter the shoulder offsets for the mainline and side roads. (Note: If both have the same offset, choose "Constant" instead of "Linear".) The offset direction must be specified. (i.e. To the right or left of the "MR" string).

4. **On the Elevations Tab**, select "Constant", and specify the cross slope and direction (up or down).

5. Click **Apply**. You should now have a shoulder string along your curb return.

Create Edge of Shoulder String - Right Side (ES2I).

Repeat the previous steps based on the circular M-String MR2I. Remember to determine the direction of MR2I so you can enter in the offsets with the correct sign.

Other Strings:

You can add back of curb strings if necessary (EB20, EB2I) by using **Minor Option 110, Add String: Constant H / Constant V,** and using strings ES20 and ES2I as Subsidiary Strings.

Edit Template Strings to "Clean Up" Intersection

Up to this point in MX, we've only dealt with the creation of strings. The most time-consuming part of MX, however, is the editing of these strings to suit your design. In this section, we'll be using the following Minor Options under Major Option EDIT:

005   Delete Part Of A String
006   Add One Discontinuity

When we delete part of a string, we permanently remove part of it between any two points. This command will be used to trim back the edge of travelled way and edge of shoulder strings associated with Side Road A. When we add a discontinuity, a "gap" is generated in a string. We'll use this command to create a gap in the edge of shoulder string ESA1 along mainline MC10. The image below shows the intersection after cleanup. The dashed lines indicate the portions of strings to be deleted, and the discontinuity to be added.
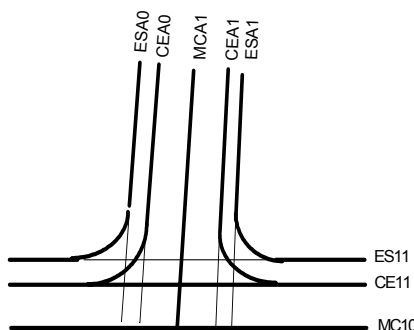
String Edits For Intersections

Trim the Left Edge Of Travelway String CEA0

1. Select Modify => Edit Points => Delete Many Points from the menu bar. The following panel will appear:

2. Select the string to be edited, CEA0.

3. You now have to determine what the start and end points are to define the section to be deleted. In our example, our side road alignment was created from the intersection with mainline. Leave the Start Point box blank on this panel in this case.

  *NOTE: Because we want to delete this first point, and all of the points up to the intersection of CEA0 and MRA0, you must click on the "END POINT" box now. By not specifying a point in the "Start Point" box, MX will assume you want to delete this point as

well. If you don't leave this box blank, MX will leave the first point in place after the operation, making it necessary for you to delete the point using another command.

4. Change the End point to Intersection PSM. Make sure multipick is turned on in the status bar, then click on the string containing the points to be deleted (CEA0), the Circular M-String (MRA0), then on a point near the intersection of these two strings. A yellow circle should appear indicating the intersection point. If this doesn't work correctly, right-click on the end point box and select the Guidance Panel to guide you through the process of specifying the intersection point.

5. Select **Apply** to delete the points.

Trim The Other Strings:

Follow the same 9 procedures listed above for the left edge of shoulder (ESA0), right edge of travelled way (CE1I), and the right edge of shoulder (ESAI).

Add A Gap In Edge Of Shoulder String - Mainline (ES1I)

To add a gap (discontinuity) in the edge of shoulder string, follow this procedure:

1. Select **Modify => Edit Points => Insert Gap Into A String** from the menu bar.

2. Click on the string to contain the gap. (ES1I).

3. You are prompted for the beginning point. Select the "Intersection" Point Selection Method, and define the beginning point as the intersection of ES1I and ESA0.

4. You are prompted for the ending point. Select the "Intersection" PSM and define the ending point as the intersection of ES1I and ESAI.

5. Click **Next** to create the gap.

Edit JOURNAL File To Remove "Bad Code"

Unless you correctly entered in all of the information in the procedures above, you'll need to edit the JOURNAL file you created to remove the lines that were recorded using the incorrect information. It's good to do this immediately after completing the intersection since the activities are still fresh in your mind. Here's the procedure:

1. Open the JOURNAL file in the Programmer's File Editor

2. Add "MOSS" as the first line to make this JOURNAL file a valid MOSS INPUT file.

3. You should see two distinct sections in the file...A DESIGN section, and an EDIT section. Make sure that there is a "999" at the end of each section to define the end of those Major Options.

4. Add "FINISH" to the very end of the file.

5. Look at the DESIGN section. Only 4 strings were created during this step of the design process, so only 4 lines of code should be in this section (2 Minor Option 145's , 2 Minor Option 101's). These LINEMODE commands are in the "fixed" format, meaning that the

data for each field begins in a certain column of the line. Don't change any of these starting columns, or your INPUT file will be corrupted. We'll be deleting only whole lines here. If you entered an incorrect radius while creating your circular M-Strings, there will be more than 1 line defining that M-String:

```
145CE1ICEA0MRA0.........etc
145CE1ICEA0MRA0.........etc.
145CE1ICEAIMRAI.........etc.
```

The example code above shows the portions of the lines to be concerned with. Note that the first two lines begin identically. You can see the string definitions in this first part. The end of the line shown above shows 2 lines defining "MRA0". Since this recorded our IGMODE session, we know that the last line of code was the one which we ended up accepting. Any lines above that using the same label definitions should be deleted. The same rule applies to the minor option 101's we used to create our edge of shoulder strings for our circular M-Strings (MRA0, MRAI.)

Summary Of Intersection Design

In the two methods described above, certain obvious advantages are to be gained by using the MXRoad Intersection Design functionality. This method automates much of tedious work required to manually create an intersection, and allows you to do other things such as regrading the intersection gutter line on the fly. It has the added advantage of creating a continuous edge of traveled way string along the side road and around the curb return. This makes for much neater earthworks operations later in the design process.